The R&D activity of multinational enterprises in peripheral economies: evidence from the EU new member states

Working Paper Series

#2010-048

The R&D activity of multinational enterprises in peripheral economies: evidence from the EU new member states

Rajneesh Narula and José Guimón

United Nations University – Maastricht Economic and social Research and training centre on Innovation and Technology
Keizer Karelplein 19, 6211 TC Maastricht, The Netherlands
Tel: (31) (43) 388 4400, Fax: (31) (43) 388 4499, email: info@merit.unu.edu, URL: http://www.merit.unu.edu

The R&D activity of multinational enterprises in peripheral economies: evidence from the EU new member states

Rajneesh Narula* and José Guimón**

Abstract:
This paper explores the impact of MNEs on innovation systems and the policy options available for peripheral economies to attract and embed the R&D activities of MNEs. After developing the conceptual and policy framework, we discuss the case of the new member states from Central and Eastern Europe that joined the EU between 2004 and 2007. We analyse the evolution of the R&D activity of MNE subsidiaries since the 1980s, contrasting the new member states with the core and Mediterranean countries of the EU. This analysis is useful to illustrate some common challenges for peripheral economies, including the difficulty of building linkages with MNEs in high value adding activities; the risk of crowding-out of domestic R&D following cross-border acquisitions; the risk of external dependency; and the limitations of protectionist policies. We recommend that governments of peripheral economies focus their efforts on fostering a demand-oriented upgrading of technological capabilities and on stimulating domestic linkages and clusters around MNEs, rather than seeking to attract supply-driven R&D.

Keywords: EU, FDI, innovation systems, innovation policies, linkages, MNE, new member states, peripheral economies, R&D

JEL: O3, F2, P3

* John H. Dunning Centre for International Business, Henley Business School, University of Reading, PO Box 218, Whiteknights, Reading RG6 6AA, UK. E-mail: r.narula@henley.reading.ac.uk

** Department of Economic Structure and Development Economics, Faculty of Economics, Universidad Autónoma de Madrid, Ctra. de Colmenar km. 15, 28049 Madrid, Spain. E-mail: jose.guimon@uam.es

UNU-MERIT Working Papers
ISSN 1871-9872

Maastricht Economic and social Research and training centre on Innovation and Technology, UNU-MERIT

UNU-MERIT Working Papers intend to disseminate preliminary results of research carried out at the Centre to stimulate discussion on the issues raised.

1 Introduction

Multinational enterprises (MNE) are progressively fragmenting their activities across regions and countries, and not just their manufacturing and sales functions, but increasingly also their most strategic activities such as research and development (R&D). Their R&D shows signs of evolving from a centralized structure towards organization that builds upon an open network of geographically dispersed R&D centres.

Partly as a result of these developments, 'national' innovation systems of most countries are becoming more integrated in global innovation networks and more dependent on foreign sources of knowledge. Indeed, the pervasive role of MNEs in a globalising world, and their increasing propensity to utilise technological resources located elsewhere, makes the use of a purely national systems of innovation approach rather limiting (Narula and Zanfei 2004).

In parallel, a growing number of countries (and sub-regions) are adopting liberal policies towards foreign direct investment (FDI). The focus of FDI promotion is shifting from quantity (i.e. maximizing FDI inflows) to quality (i.e. matching FDI to the host country's industrial development aspirations). Top among development aspirations is to specialize in high technology sectors (e.g. biotechnology, nanotechnology, software, electronics) and high value adding corporate functions such as R&D. This has led to intensified competition among locations to attract the R&D activities of MNEs, although only a few locations provide the specialised and well-developed innovation systems that are needed.

We refer to the EU new member states in this paper as peripheral economies, to distinguish them from the limited purview of developing countries (and the somewhat tautological concept of emerging countries), as well as allowing us to acknowledge the catching-up status of countries and regions that are officially classified as developed. The process of catching-up applies not just to countries with low GDP, but also includes those that are disadvantaged by virtue of other exogenous factors. The concept of a periphery also allows us to acknowledge that catch-up is relative to the existence of a core. A peripheral economy can be characterized by all (or several) of the following: it plays an insignificant role as either host or home to MNEs; engages in relatively little trade in intermediate and manufactured goods; contributes relatively little to innovation and scientific progress; is weakly linked or accessible physically to the core; does not play a significant role in decision-making within supranational organizations; and does not share a significant number of formal institutions with the core countries (Benito and Narula 2008).

Peripheral economies – by and large – are increasingly aware of the importance of attracting R&D by MNEs and its role as a mechanism to catch-up with the core. Indeed, in many peripheral countries R&D by MNEs accounts for the largest share of business expenditure in R&D, often because domestic firms under-invest in R&D. This forms the focus of the current paper. How realistic is this aspiration for greater dependence on MNEs as a cornerstone of innovation policy amongst peripheral economies? Can peripheral economies attract the R&D activities of MNEs and embed them into their innovation systems? What policy options and tools are available to enable this? We illustrate our arguments and reasoning by analyzing the case of the ten new member states (NMS) from Central and Eastern Europe that joined the EU in 2004 and 2007. These countries provide a useful illustration for our analysis given their adoption of FDI-assisted industrial development strategies since the 1990s, but have shown varying degrees of success in building up their innovation systems through MNE participation.

The rest of this paper proceeds as follows. Section 2 provides a theoretical framework to analyze the interaction between MNEs and innovation systems. We use a broad definition of innovation systems, taking it to include not only science and technology-based learning but also learning through experience and interaction. Building on this framework, in Section 3 we discuss the rationale for innovation policy for peripheral economies. Section 4 examines the evidence from the NMS, and the evolution of R&D activity of MNE subsidiaries since the 1980s, contrasting the NMS with the core and Mediterranean countries of the EU.

2 The interaction between foreign MNEs and national innovation systems

The potential benefits of attracting the R&D of MNEs comprise not only *direct* effects associated with increased innovative activity and employment, but also *indirect* effects that arise from linkages and spillovers (see left side of Figure 1). MNEs develop a variety of formal and informal agreements and linkages with domestic actors that promote *learning-through-interacting* from MNE subsidiaries.

FIGURE 1

Among other indirect effects, the R&D of MNE subsidiaries may incorporate locally produced components into new products. This opens up new markets for domestic firms, as well as new opportunities to collaborate with MNEs in R&D. Another source of indirect benefits is a *competition effect*, whereby the presence of MNE subsidiaries that have a higher productivity in a given industry spurs domestic competitors to raise their productivity by improving the efficiency of their operations to be able to compete (Görg and Strobl 2001; Narula and Dunning 2010). This spreads further to non-related industries where similar techniques may be applied through a *demonstration effect*.

R&D activity of MNE subsidiaries enables the transfer of tacit technological knowledge, which is hard to acquire by other means. This may occur through *employment effects*, where domestic firms benefit from training provided by MNE subsidiaries to their employees, who subsequently become available to domestic firms through the job market or may establish new firms themselves. Another source of potential benefits are *imitation effects*, since the successful operation of an R&D subsidiary may lead to a cascade of imitators (Krugman 1997).

It is difficult in practise to separate those different modalities by which MNE subsidiaries may affect innovation systems, but overall it is reasonable to assume that the presence of MNE subsidiaries active in R&D enables host locations to integrate more advantageously into global innovation networks (Cantwell and Piscitello 2000; Carlsson 2006; Narula and Dunning 2010; Santangelo 2005). MNE subsidiaries often act as *anchor tenants* (Agrawal and Cockburn 2003) in their host innovation systems and as a catalyst for technological upgrading.

However, the constituents of innovation systems need a certain level of technological expertise to be able to benefit from the indirect effects associated with the R&D activity of

MNEs. Along these lines, Cohen and Levinthal (1989) define *absorptive capacity* as the ability to acquire, assimilate and exploit knowledge developed elsewhere. Indeed, from a growth and learning perspective, externalities only matter if they can be captured by other economic actors in the host economy. For externalities to be optimally utilised there needs to be an appropriate match between the nature of potential externalities and the absorptive capacities of domestic actors.

The impact on innovation systems also depends on whether the activities undertaken by MNE subsidiaries match the current structure and developmental aspirations of host innovation systems. The benefits for innovation systems will be larger when MNEs engage in projects that contribute to enhancing domestic technological strengths and location-specific assets (Pearce 2004).

The R&D of MNEs also entails some potential risks (see right side of Figure 1). In some instances it may cause a *crowding-out* effect whereby innovative domestic firms are displaced, out-competed or pre-empted by foreign-owned MNE subsidiaries. This is not only the case in the product market but also in the factor market: foreign presence might damage the technological competitiveness of local firms through intensified competition for limited specialized assets, including human capital (Girma et al. 2001, Meyer-Krahmer and Reger 1999). Thus MNEs do not always contribute to upgrading, but rather may act to reduce the host country's long-run potential (Rugman and Verbeke 2008). Barrios et al. (2006) found that in Ireland a negative competition effect initially prevailed, leading to the exit of domestic competitors, but over time this was gradually outweighed by other positive externalities deriving from linkages and spillovers. However such a positive long-run outcome is by no means guaranteed.

An additional concern is the potential loss of control over domestic innovative capacity, leading to a higher external dependency. This may happen when FDI in R&D occurs through the acquisition of an R&D-intensive firm. While the only short term effect for the host country is a change of ownership, in the medium- to long-run there is a trade-off between the potential for expansion and indirect benefits and the risk that the foreign acquirer downgrades the subsidiary's R&D mandate to avoid duplication. This explains why some governments opt for *techno-nationalistic* policies oriented to the protection of 'national champions' from foreign acquirers (Archibugi and Iammarino 1999; Cantwell et al. 2004; Ostry and Nelson 1995).

The interaction between national innovation systems and MNEs needs to be interpreted within the context of global corporate strategies. Since firms tend to build value-added abroad incrementally, their embeddedness in innovation systems is often a function of the duration of their presence. R&D mandates usually emerge as a sequential process whereby manufacturing or customer support subsidiaries already located in the country progressively engage in R&D, and in subsequent phases may further expand the competence and scope of their R&D activity (Guimón 2009). Indeed, the evolution of MNE subsidiaries should be interpreted not as a discrete, single-period flow, but as a multi-period building up of FDI stock through deepening and spreading of value-adding activities, not all of which occur as a consequence of new flows of foreign capital (Narula and Dunning 2010). The scope and competence levels of the MNE subsidiary are co-determined by a variety of factors, including MNE internal factors such as its internationalization strategy, the role of the new location in its global portfolio of subsidiaries and the motivation of the investment, in addition to the available location-specific resources which can be used for that purpose (Benito et al. 2003).

The type of R&D activities that MNE subsidiaries undertake may respond to different strategic motivations. In certain cases the strategic motivations may be demand-oriented, associated with a large market or the availability of generic price-sensitive inputs. In such cases, the internationalization of R&D is driven by *knowledge-exploiting* motivations, related to the adaptation of products, services or processes to overseas markets. We refer to this as *demand-driven R&D*.

In other circumstances MNEs seek to establish themselves in particular locations to undertake innovation because of specific location-bound knowledge assets, which may include quasi-public goods provided through universities and public research institutes. In this case, the internationalization of R&D is driven by *knowledge-augmenting* motivations; by the aim of tapping into foreign sources of knowledge and specialized clusters. We refer to this as *supply-driven R&D*.

The internationalization of corporate R&D was primarily demand driven in the past, following the internationalization of manufacturing (Mansfield et al. 1979). But in recent years supply driven motivations have become increasingly important (Carlsson 2006, Hedge and Hicks 2008).

It seems reasonable to assume that peripheral economies are more likely to attract demand-driven rather than supply-driven R&D, given their lower technological capabilities relative to the core. In a survey of corporate motivations with a sample of 249 MNEs, Thursby and Thursby (2006) show that the kind of R&D activities by MNEs in emerging countries like China and India normally involve *familiar science*, rather than *new science* which remains concentrated in the core countries[1]. Similarly, Puga and Trefler (2010) suggest that peripheral economies normally engage only in incremental (rather than radical) R&D, related to addressing production-line bugs and suggesting minor product improvements.

The distinction between demand and supply driven R&D is relevant for the purposes of impact evaluations and policy analysis. Demand-driven R&D by MNEs tends to be more *footloose* and highly dependent on the continuation of manufacturing activities. In contrast supply-driven R&D activities tend to be more autonomous and knowledge-intensive, and imply a considerably greater dependence on domestic knowledge sources and infrastructure. That said, the developmental impact of demand-driven R&D should not be neglected. Rather, it should be seen as an opportunity for an evolutionary upgrading based on learning-through-interacting with MNEs.

3 Rationale and options for promoting R&D through policy intervention

[1] Thursby and Thursby (2006: 1547) define new science as "novel applications of science" and familiar science as "applications of science currently used by the firm and/or its competitors".

The rationale for public intervention to attract R&D in general derives from the presence of *market failures* or imperfections, as well as the peculiar nature of knowledge. Governments are concerned with enhancing R&D activity by firms (both MNEs and domestic firms) for at least three overlapping reasons. First, without government intervention, firms may under-invest in R&D, given their bounded rationality, risk-aversity, and the path dependent nature of their activities. The risky nature of R&D is often reflected in the cost of capital to the firm intent on undertaking R&D, and the higher the risk, the more difficult it may be to acquire capital to undertake it. This supports the case of government intervention, for example by offering fiscal and financial incentives to firms undertaking R&D.

Second, governments are faced with the difficulty of sustaining economic growth through encouraging innovative activity by providing monopoly power to inventors so that they may continue to innovate at a socially optimal level. Where intellectual property rights (IPR) protection is weak, firms will under-invest in R&D when they are uncertain of appropriating sufficient returns. Thus, another role of governments is to encourage a transparent and enforceable IPR regime[2].

Third, governments also aim at maximising the diffusion and availability of knowledge generally by encouraging competition. This entails the prevention of oligopolistic and monopolistic behaviour in asset creation and utilisation. It is axiomatic that demand is necessary as a catalyst to innovation, and the competition to survive among firms in a given industry drives the generation and diffusion of technology. Dasgupta and Stiglitz (1980) among others have shown that there is a positive relationship between competition in R&D and the level of innovation. On the one hand, when there are a larger number of firms engaged in R&D in a given industry, the average level of R&D investment per firm falls, but the total investment in the industry rises. On the other hand, innovative activity may be encouraged by industry structures in which firm concentration is substantial.

Maintaining an optimal level of R&D requires governments to provide public goods by contributing to the development of the necessary formal institutions, infrastructure and human capital. The rationale for policy intervention is irrespective of country. However, in peripheral economies the challenges of under-investment in R&D activities are especially acute. The kinds of policy intervention needed changes with the evolution of the innovation system. Less developed peripheral economies need to focus on generic policies to improve the absorptive capacity of their innovation systems. After reaching a threshold level of technological capabilities, more specific industry and technology-specific support is required.

[2] Some countries have used competition policy to great effect by offering MNEs oligopolistic markets on the condition that knowledge-intensive and R&D activities are undertaken locally, whether independently or in conjunction with domestic firms (Liang 2004). Apart from the fact that it represents a performance requirement that contravenes international regulations (such as WTO rules), this policy option is not available to many peripheral economies lacking a large market size that could be used as a bargaining tool.

Active intervention by governments to stimulate R&D by MNEs is controversial in the neoliberal approach that has dominated policy over the last two decades, because it sometimes leads to a more inefficient allocation of resources; in other words, to *government failures* (McKean, 1965). While acknowledging the dangers of government failures, scholars such as Lall (2004) have argued that the need for policy intervention has become stronger given the fast pace of globalization and technological change. Indeed, increasing R&D by MNEs requires a more proactive kind of intervention, unlike generic FDI policies which can rely largely on investment liberalisation along with marketing and promotion.

3.1 The specific case of R&D by MNEs in peripheral economies

Many governments of peripheral economies tend to measure their potential attractiveness to MNEs based on their basic infrastructure and low labour cost. However, MNEs rarely locate their R&D activities based on cheap factor inputs, and where they do so, it tends to be of the sort that is footloose, such as clinical trials for pharmaceuticals (Filippov and Kalotay 2008). It is axiomatic that as industrial development takes place, the comparative advantage of peripheral economies needs to shift away from low value to higher value-adding activities, and the government should contribute to building the institutions and infrastructures that are necessary for upgrading.

Promoting absorptive and technological capabilities requires greater attention to the interactions and linkages between actors, overcoming *systemic failures* or inefficiencies. Systemic inefficiencies often require intervention because of the lack of (well developed) networks between the different actors of the system, often as a result of the weakness of both formal and informal institutions. In this context, an important role of policies is to facilitate interaction and linkages between MNE subsidiaries and other agents of the domestic innovation system. For example, governments often offer assistance to foreign investors to find suitable local suppliers or partners and promote the co-location around technology parks of foreign MNEs with local firms and universities. Another typical way of stimulating linkages is by designing specific fiscal incentives or subsidies to R&D projects where MNE subsidiaries collaborate with local universities and firms. This kind of policies are based on the premise that benefits for the host innovation system are magnified when MNE subsidiaries become embedded by collaborating in their innovative efforts with local firms, universities, R&D centres or business associations.

Along those lines, in many peripheral economies large projects are attracted with the intention of acting as a *seed*, such that a cluster can be built around them. The development of clusters around MNEs increases the likelihood of an upward evolution of MNEs competence and scope. A frequently cited example of success is the investment of Intel in Costa Rica in the mid 1990s, which was taken by the government as the basis for building a sizable domestic industry of both foreign and local firms, representing the consolidation of the national strategy to diversify out of apparel and natural resources toward electronics and other high technology industries (Mortimore and Vergara 2006, Mytelka and Barclay 2006).

However, creating clusters around MNEs is not an easy task for peripheral economies. A critical challenge is that as MNEs increasingly seek to rationalize their activities, decisions about local linkages are not always made at the subsidiary level, but rather at the headquarters level by comparing the various options available to the MNE globally. This kind of *global sourcing* strategies imply that MNEs rely on a handful of strategic partners to provide inputs to their global value chains, rather than on different suppliers in each individual country. Therefore governments of peripheral economies need to create incentives for the MNE to consider local partners, and not expect these to happen naturally. Existing firms may not currently meet the quality and reliability requirements of the MNE. Thus policies to upgrade reliability and quality in local firms are of critical importance.

Another challenge in creating clusters around MNEs is associated with matching the industrial structure and comparative advantages of the region with the kinds of FDI that are being attracted. Benefits from FDI are maximised when the kinds of investment projects being attracted are matched with the potential clusters of domestic competitiveness which MNEs may be able to tap into. This supports the case for a selective approach to FDI promotion, where only limited resources are available. Policymakers have to place the endowments of the innovation system in a global context, identifying spaces for coupling domestic innovatory capacities with the dynamics of global value chains.

As argued earlier few peripheral economies have been successful in attracting supply-driven R&D. They have been more successful in promoting the incremental upgrading of existing subsidiaries towards demand-driven R&D. In this context the focus of policies should be to foster demand-oriented upgrading of technological capabilities in response to MNE current activities, aimed at creating the conditions that enable existing subsidiaries to embrace R&D mandates, rather than radical (and expensive) actions to specialize in new R&D areas with the hope that this will be followed by greenfield FDI in higher value adding activities. The aim is to promote sequential investments of MNE subsidiaries such that they are simultaneously deeply integrated with the MNE global structure and deeply embedded within the domestic innovation systems (Figueiredo 2011). This implies enhancing the benefits for the domestic innovation system and increasing the strategic importance of the subsidiary to the MNE headquarters, such that sequential investments are increasingly knowledge intensive. This entails engaging in close collaboration with the managers of MNE subsidiaries, identifying individual opportunities for upgrading, and offering them customized *aftercare* services and incentives.

Although it may seem paradoxical, attracting demand-driven R&D from MNEs also requires supply-side investment in R&D infrastructure. This includes investments in long-term research projects in specific areas, as is the case with national laboratories, academies of science, etc. These generate outputs such as academic publications, patents, etc., which act as an important source of knowledge inputs for larger research establishments by MNEs and domestic firms. Public research institutes are also necessary to provide technical services for testing and as a consultancy service to firms as part of the infrastructure for metrology, standards, testing and quality control. There are also demand-driven public institutes which actively work in particular sectors or clusters, whose primary purpose is to develop specific innovations to meet the need of a sector or group of firms. Another critical role of governments is to contribute to improving human resources capabilities in line with demand. R&D requires not only engineers and scientists, but a broad range of skills including technicians, administrative staff and skilled workers. Educational institutions need to focus on all of these different levels, and develop programmes in the appropriate industries and specialisations for which demand exists, in addition to generic subject areas. Specific government actions and strategies should follow from an intelligence gathering and technology foresight exercise in continuous dialogue with MNE subsidiaries.

Despite the challenges for peripheral economies there are also a number of examples in recent history showing that opportunities for upgrading exist. Ireland is a clear example of a formerly peripheral economy that achieved a high degree of success through active policies aimed at FDI-assisted upgrading, focussing on high technology industries and high value adding corporate functions such as R&D and regional headquarters (Harris 2005; Ruane and Buckley 2006). In more recent years, several Asian countries have also been very successful in attracting the R&D of MNEs, challenging the traditional dominance of the triad countries (North America, Western Europe and Japan) (Bruche 2009). This happened in the 1990s in a number of smaller, newly industrializing countries like Israel, Korea, Taiwan and Singapore, while since the 2000s we have witnessed the emergence of Brazil, China and India as key players in the new geography of corporate R&D. On the one hand, demonstrate the potential for engaging into the global R&D networks of MNEs. On the other hand, the growing attractiveness of Brazil, China and India as locations for corporate R&D may make competition harder for other peripheral economies. Indeed, while the emerging new geography of corporate R&D is more multipolar, this does not mean it will be inclusive.

4 The case of the EU new member states

We now focus on the ten new member states (NMS) of the EU from Central and Eastern Europe, which share certain key features that can realistically constitute the basis for common impact assessments and policy recommendations. These countries consist of Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia (which joined the EU in 2004) and Bulgaria and Romania (which joined in 2007)[3]. We will contrast the NMS with the *core* and *Mediterranean* countries of the EU. Among EU member states, the core countries (Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Luxembourg, Netherlands, Sweden and United Kingdom) enjoy the highest income per capita, are the most advanced technologically, and the most likely to attract the R&D of MNEs. Mediterranean countries (Spain, Italy, Portugal and Greece) have lower levels of income per capita and are less advanced technologically than the core, but have been engaged in a process of convergence in the last two decades, with different degrees of success. They are also peripheral, although arguably to a lesser extent than the NMS.

4.1 The impact of transition, privatization and EU accession

FDI was virtually non-existent prior to transition and any linkages of national innovation systems to international sources of knowledge were sporadic and state controlled (Radosevic 1999, 2003). But during the 1990s, the transition from a socialist to a market system and the prospects of EU accession brought radical changes to the socioeconomic structure of the NMS, in particular through rapid economic liberalization and the adoption of Washington Consensus type policies. In just a few years, many state-controlled industries were transferred to foreign ownership through privatization. This was exacerbated by

[3] Malta and Cyprus, which also joined the EU in 2004, are excluded from our analysis given their small size and the fact that they are significantly different from the rest of NMS; both are Mediterranean islands without a socialist past.

national budget constraints, pressures from supranational institutions (including EU, IMF, WTO) and, in some instances, the inability of domestic capitalists to compete effectively with foreign firms. FDI grew dramatically and, as a result, the share of foreign ownership in total capital stock is already typically much higher than in the older EU member states, although with considerable variation across countries and sectors (Narula and Bellak 2009). Garmel et al. (2008) predict that three-quarters of capital in the NMS will ultimately be acquired by investors from the other EU member states in the long run.

Liberalization, privatization and inward FDI contributed to institutional change and economic catching-up (Lavigne 2000; Radosevic 2006). Foreign investors initially moved into the region due to cost advantages (low labour costs and low taxes), but with time many MNEs upgraded their operations, as evidenced by the growth of high technology industries and high technology exports (Álvarez and Guimón 2010). During the 1990s real wages in the NMS rose steadily, especially in foreign-owned companies (Hancké and Kurekova 2008). According to Chobanova (2009), the preservation and effective restructuring of existing socialist supplier networks enabled the formation of transnational linkages between local firms and MNEs, which contributed to industrial upgrading. Foreign-led upgrading is further evidenced by the fact that MNE subsidiaries performed significantly better than local firms (Djankov and Murrel 2002).

FDI contributed to the upgrading of innovation systems in the NMS by helping to increase the commercial orientation of innovative efforts and to better integrate into global innovation networks (Inzelt 1999). Günther et al. (2009) show that many of the MNE subsidiaries in Central and Eastern European countries are to some extent technologically active in terms of conducting their own R&D and generating product and process innovations, and they argue that this stimulates technological transfer and upgrading.

In general terms, the R&D of MNE subsidiaries in the NMS has been primarily demand-driven, linked to manufacturing operations, aimed at process rather than product innovations, or at minor product adaptations to meet the specificities of local demand (Chobanova 2009; Günther et al. 2009; Hancké and Kurekova 2008; Radosevic 2006). Supply-driven motivations (i.e. tapping into localised knowledge and technology) seem to be less relevant, suggesting that in general terms these countries have not developed their science and technology infrastructure to the level that they possess an absolute advantage in basic research for which MNEs seek to locate a stand-alone, specialised R&D facility.

As EU integration has proceeded, MNEs have continuously restructured their EU-wide supply chains to better rationalize their operations (Dunning 2008). Majcen et al. (2009) notes how EU countries that are furthest away from convergence with the EU norm are often host to single-activity subsidiaries, primarily in sales and marketing or labour-intensive manufacturing and assembly, as well as in natural resource extraction. In contrast, the most advanced economies with domestic technological capacity, such as the core EU countries, host the least truncated subsidiaries, often with R&D departments and (regional) headquarter functions. According to Chobanova (2009) MNEs locate their R&D centres in the core EU countries and are unwilling to further expand their R&D operations elsewhere within the EU. Other authors reach similar conclusions (Hancké and Kurekova 2008; Narula and Bellak 2009).

When evaluating the impact of MNEs on the innovation systems of the NMS, it is essential to consider that much of the R&D activity of MNEs was inherited through *privatization-driven acquisitions*, and in many cases the R&D function was downsized and linkages replaced with the MNE's global network of affiliates and partners (Čadil et al. 2007). The developmental impact of FDI was often limited by the inability of domestic actors to build the kind of linkages with foreign MNEs that enhance the indigenous innovation system, either because they lacked sufficient absorptive capacity, because they operated largely in different sectors, or because they evolved separately. Moreover, in some instances local actors were reluctant to integrate MNEs into the system (Damijan et al, 2003; Sinani and Meyer, 2004; Javorcik and Spatareanu, 2008). Very often, the activities conducted by domestic firms as a result of their interaction with MNEs were low value-adding tasks characterized by a somewhat hierarchical relationship with the MNE. Cases of deeply embedded MNEs are often attributable to *domestic production substitution*, i.e. the replacement of previous state-owned firms by MNEs in the industrial milieu of the host country through acquisitions.

A key challenge for governments of the NMS was to try to ensure that privatized firms continued to operate, create employment, perform R&D and source locally. During the first years of transition the NMS encouraged MNE embeddedness through protectionist policy measures. But EU accession constrained these policy options. Upon accession, many MNEs relocated activities as market distortions introduced by protectionist regulations disappeared (Chobanova 2009; Meyer and Jensen 2003). In the absence of large markets or sufficiently well-developed innovation systems and industrial clusters, many MNEs preferred to seek economies of scale and scope in their existing activities within the core EU countries despite the low cost advantages the NMS offered. The relatively safe and protected markets of the NMS were liberalised and restructured in the wake of EU membership.

Despite our attempts to generalize, it is important to stress that there are significant differences across countries within the NMS as a result of path dependencies which reflect different socio-political and economic histories. In particular, two subgroups of countries can be identified within the NMS. The first group (Czech Republic, Slovakia, Hungary, Slovenia, Estonia and Poland) have proceeded the furthest from a centrally-planned economic structure, and towards economic convergence, and have been more successful in attracting and embedding the R&D activity of MNEs. The second group, comprising Bulgaria, Romania, Latvia and Lithuania, are still somewhat in transition, and have had more difficulties in embedding MNEs and attracting high value-added FDI. Chobanova (2009) attributes this to the differences in their stage of economic development, absorptive capacity, legislative frameworks and industrial policies, and, in addition, to the fact that some countries showed higher transparency in the privatization schemes in the early 1990s, while others delayed market reforms because of political disagreements and multiple shifts in legislations. To some extent all the NMS still demonstrate artefacts of the pre-transition era in their innovation systems, because modifying and developing informal institutions is a complex and slow process, as it takes considerable time and effort to create informal networks of government agencies, suppliers, politicians and researchers which, once created, have a low marginal cost of maintaining.

4.2 Some empirical evidence

The aim of this section is to further assess the role of foreign-owned MNEs in the innovation systems of the NMS through a descriptive analysis of aggregate indicators. We first focus on indicators of R&D expenditure and patent applications, using the OECD and the US patent office as statistical sources. Subsequently we provide evidence of the functional structure of Greenfield FDI building on the Ernst and Young database of investment announcements.

A typical way of measuring the role of MNEs in innovation systems is to look at the R&D expenditure of MNE subsidiaries relative to total business expenditure in R&D[4]. Table 1 shows that from 1994 to 2006 this indicator grew much faster in the NMS than in the core and Mediterranean countries; from 14.5% in 1994 (well below the average for the rest of the EU) to 50.6% in 2006 (significantly above the average for core and Mediterranean countries). There are, however, large differences among the four NMS in the sample, ranging from 64.1% in Slovakia to 21.7% in Poland. Compared to other EU countries, in 2006 only Ireland showed a higher ratio than Slovakia, Czech Republic or Hungary; but Ireland is an outlier in the EU in terms of its high degree of openness and its MNE-driven technological development strategy. The data shows clearly how the importance of MNE subsidiaries in total business expenditure in R&D increased consistently and at a significantly higher rate in the NMS than in the core and Mediterranean countries.

*** TABLE 1 ***

An alternative way of quantifying foreign participation in national innovation systems is through patents, which has the advantage of allowing us to cover all EU countries and a longer time frame. Patent documents report the name of the inventor(s) and the owner(s), along with their countries of residence. When the owner's and inventor's countries of residence differ, this indicates cross-border ownership of inventions. In such cases, the owner is usually an MNE and the inventor an employee of a foreign subsidiary (Guellec and van Pottelsberghe de la Potterie 2001). Thus, foreign ownership of domestic inventions reflects the international expansion of the innovative activities of MNEs and expresses the extent to which foreign firms control domestic inventions.

Based on USPTO data, Table 2 shows that while foreign ownership of domestic inventions has remained relatively stable in the core and Mediterranean countries during the last two decades, it has grown substantially in the NMS, reaching 77.6% in 2001-2005; a much higher level than in core and Mediterranean countries. In the NMS, foreign ownership of domestic inventions grew from relatively low levels in the early 1980s as the first steps of transition were taken, but growth was especially pronounced after 1990. Altogether, as in the case of R&D data, patent indicators show clearly the pervasive process of increased foreign dependence of national innovation systems in the NMS.

*** TABLE 2 ***

---

[4] This indicator is available from the AFA database of the OECD, but only for a limited set of countries and generally starting in 1994. In particular, it only provides data for 4 out of the 10 NMS. This can be contrasted with a sample of 3 (out of 4) cohesion countries and 8 (out of 11) core member states.

Again, significant differences by country can be observed. An extreme case is Romania, where all USPTO patents invented domestically between 2001 and 2005 were owned by foreign entities. On the other extreme, Slovenia shows the lowest level of foreign ownership of domestic inventions, at a relatively high 54.4%. The problem is that in six of the ten NMS the total number of patents is zero or very low in the initial periods considered. This may reflect that many of the innovative activities undertaken in peripheral economies are of the demand driven type, and thus less likely to result in patent generation.

Of course, the high share of foreign participation may either be the result of a dynamic system that is successful in attracting the R&D of MNEs or, it may reflect the crowding-out of domestic innovative efforts. To further clarify, Table 3 shows the growth rates of total patents invented domestically, with a breakdown by nationality of owner, in the three groups of EU countries. While domestic patents with a foreign owner grew faster in the NMS than in the core and Mediterranean countries, this led to a decrease in the total number of patents with a national owner. In contrast, in the Mediterranean and core countries the growth in foreign-owned patents is matched with a positive growth in domestic patents. This indicates a crowding-out effect in the NMS, which contrasts with the crowding-in effect in core and Mediterranean countries.

*** TABLE 3 ***

These statistics do not allow us to differentiate between Greenfield investments and transnational M&As. In order to assess the impact of FDI in R&D on national innovation systems it is important to control for the entry mode, especially in the NMS where much of inward FDI was driven by privatizations leading to foreign acquisitions in the 1990s. The critical issue is whether beyond the transfer of ownership there have been new investments in R&D by MNEs in the NMS. We analyze this using the European Investment Monitor database of Ernst and Young, comprising a sample of 22 503 announcements of inward FDI projects in EU countries from 1997 to 2006[5].

Despite certain caveats[6], this database is one of the few sources available to study empirically the functional structure of FDI within the EU. In total, there were 174 announcements of new R&D investments from MNEs in the NMS during that period. Figure 2 shows that the share of R&D projects in total FDI projects is much larger in the core and Mediterranean countries than in the NMS. The share of investment in headquarters functions is also lower in the NMS, while the share of manufacturing projects is much higher. These results provide additional empirical support to the research of other scholars (Chobanova 2009; Hancké and Kurekova 2008; Majcen et al. 2009), that on the functional

[5] The database includes investments made by European and non-European firms in all the EU member states. It includes greenfield investments and expansions of existing subsidiaries but excludes M&As. It also excludes real estate investments; retail, leisure and hotel facilities; fixed infrastructure investments; and extraction activities. The information of this database is compiled through global, national and regional media; financial information providers (such as Reuters); corporate websites; and government websites (such as the websites of investment promotion agencies).

[6] An analysis based on investment announcements has limitations because some are better publicised than others. However, we do not believe that the comparative analysis of the functional structure of FDI announcements will be biased on an aggregate level. A more significant problem is that the database reports on the number of FDI project announcements, but does not provide sufficient information about the quantity of the investment or the number of jobs created.

specialization patterns within the EU, with the NMS becoming more specialized in manufacturing operations and the core countries retaining the most strategic R&D and headquarters functions.

*** FIGURE 2 ***

An analysis by country shows that there are significant differences among the NMS (Table 4). The Czech Republic, Slovenia and Hungary exhibit the highest relative capacity to attract FDI in R&D, although the share of this kind of investments is still below the average in the core and Mediterranean countries. At the other extreme, Estonia, Lithuania and Latvia exhibit the lowest share of R&D projects.

*** TABLE 4 ***

Finally, Table 5 provides some indicators of the innovation systems of the NMS, showing that on average the NMS still lag behind not only the most technologically advanced core countries, but also the Mediterranean countries of the EU. As with the previous indicators, there are significant differences among the different NMS, with the most advanced countries being Czech Republic, Estonia, Hungary, Slovenia and Slovakia, which on some science and technology indicators rank better than Mediterranean members of the EU (although still with a significantly lower level of GDP per capita).

*** TABLE 5 ***

4.3 Discussion

Inward FDI had a very important role in the transition process and has often been regarded as one of the main benefits of EU accession for the NMS. But the overdependence on FDI to drive industrial upgrading has its risks, which are becoming more evident in the post EU-accession era. FDI per se does not guarantee increased productivity and industrial upgrading in the long term: the critical issue is the ability of the country to embed FDI and to raise its technological capabilities as wages rise and skill demands change. EU membership meant that import-substitution type policies were no longer feasible as an instrument to force embeddedness; this implied a growing pressure to develop the kind of sustainable competitive advantages that enable upgrading in corporate value chains. The focus of industrial policies in the post EU-accession era has needed to shift towards selective interventions to support the upward evolution of existing MNEs.

Based on R&D expenditure and patent indicators, we have shown how MNEs already account for the majority of the R&D inputs and outputs in these countries, meaning that they have already attracted significant flows of R&D-related FDI. In fact, the relevance of foreign MNEs in national innovation systems is much higher on average in the NMS than in the core and Mediterranean countries. The challenge is to enhance the benefits and mitigate the risks associated with this rapid growth of FDI in R&D.

We also find that there is certain degree of crowding-out and that, following massive privatizations, the subsequent Greenfield investments in the region have been primarily oriented to manufacturing operations, while the share of R&D and headquarter investment announcements have been lower than in the rest of the EU.

Our analysis suggests that most of the R&D of MNEs in the NMS is demand-driven. This is a frequent scenario in peripheral economies, and has important policy implications such as the importance of fostering clusters, linkages and a demand-oriented upgrading of human capital and R&D. Thus, governments of NMS should act as linkage facilitators and skills coordinators. This is not limited to promoting linkages between MNEs and domestic suppliers. It should also include linkages with universities and public research centres, and extend further to provide assistance to MNEs in recruiting local researchers and bringing scientists and engineers from abroad. This calls for a closer connection between FDI, industrial and innovation policies. However, the tendency in many NMS has been to focus on FDI flows, but not on the aftercare or embedding aspect necessary for FDI-assisted development (Chobanova 2009)[7].

Regional authorities and intermediary organizations such as chambers of commerce and business associations can play an important role in the upgrading and embedding of MNEs by fostering linkages and contributing to the necessary development of human capital and infrastructures (Hancké and Kurekova 2008). In addition, governments of the NMS are advised to further exploit the advantages that EU membership brings to their capacity to attract the R&D of MNEs, in particular by participating further in, and building closer linkages with, the European Research Area. Moreover, EU cohesion policies are becoming more targeted to innovation and knowledge, which opens up new funding opportunities for incentive schemes in the NMS. As an example, in 2009 Spain was the first country to use the new European Technology Fund, and the Spanish government decided to dedicate part of it to stimulating the R&D activity of foreign MNEs by allocating 24 million euro for subsidies to the national investment promotion agency.

Our study should be taken as a broad framework that would need further refinement to better address the specificities of individual NMS and to better account not only for science and technology based learning but also for learning through experience and interaction with MNEs. Moreover, it is still too early to assess the full impact of transition, EU accession and inward FDI on the upgrading of innovation systems in the NMS, since those transformations are still recent in history and would need to be analyzed from a dynamic, longer-term perspective. The global economic and financial crisis that started in 2007 has had a very negative effect on FDI inflows and MNE operations in the region, questioning the formerly prevalent optimistic view of the success of FDI-assisted development and raising. This raises concerns of industrial downgrading and subsequent specialization in the lower value adding segments of corporate value chains.

5 Conclusions

[7] Some of the NMS, however, did set up successful programs to foster linkages and embeddedness. For example, in 1999 the Czech Republic launched the "Supplier Development Programme" with the objective of intensifying and strengthening contacts between domestic suppliers and MNEs. In Hungary, a linkage promotion programme targeted to the automotive sector was introduced in 1997 under the name of "Supplier Target Programme", which was re-launched in 2000 as the "Integrator Supplier Target Programme" with the aim of developing further the already existing supplier networks.

Attracting and embedding the R&D of MNEs is arguably a critical aspect for industrial and technological upgrading. Peripheral economies have more difficulties in this endeavour, because (among other reasons) peripherality implies fewer location advantages relative to the core and a lower level of absorptive capacity.

In this paper we have discussed the role of government policies using an innovation systems framework, suggesting a coordinated and systemic approach focused on subsidiary development and linkage facilitation. Governments of peripheral economies need to set up realistic targets to better match the developmental *aspirations* to guide their policy strategies within the *reality* of global innovation networks. It seems clear that peripheral economies are not likely to attract significant supply-driven R&D in the near future, because the quality of the specialised S&T infrastructure needed is such that there are only a few locations which have the appropriate endowments. However, peripheral economies may attract demand-driven R&D which can also lead to an incremental upgrading of technological capabilities. We have argued that governments of peripheral economies need to focus on fostering a demand-oriented upgrading of technological capabilities and on stimulating domestic linkages and clusters around MNEs.

The study of the particular case of the new member states of the EU from Central and Eastern Europe is useful to illustrate how our analytical framework can be applied in practice and to discuss some common challenges for peripheral economies. These include the continuous restructuring of global corporate networks; global sourcing strategies; the difficulty of building linkages with MNEs; the risk of crowding-out of domestic R&D following transnational acquisitions and privatization; the risk of external dependency; and the limitations of import-substitution type policies. Since MNEs already account for the majority of the R&D inputs and outputs in the new member states, their experience may inform policy learning in other peripheral economies that are at an earlier stage of internationalization of their innovation systems.

References

Agrawal, A. and Cockburn, I. (2003). The anchor tenant hypothesis: exploring the role of large, local, R&D-intensive firms in regional innovation systems. International Journal of Industrial Organization 21(9), 1227-1253

Álvarez, I. and Guimón, J. (2010). Los sectores de alta tecnología en la UE. In: Claves de la Economía Mundial, ICEX, Madrid (forthcoming)

Barrios, S., Görg, H. and Strobl, E. (2005) Foreign direct investment, competition and industrial development in the host country. European Economic Review 49(7), 1761-1784

Benito, G., Grogaard, B. and Narula, R. (2003). Environmental Influences on MNE Subsidiary Roles: Economic Integration and the Nordic countries. Journal of International Business Studies 34(5), 443-456.

Benito, G. and Narula, R. (2008). States and Firms on the Periphery: The Challenges of a Globalising World. In: Benito, G. and Narula, R. (eds.), Multinationals on the Periphery. Palgrave, London.

Bruche, G. (2009). The Emergence of China and India as New Competitors in MNCs Innovation Networks, Competition & Change 13(3), 267-288.

Čadil, V., Kučera, Z., Pazour, M., Fortanier, F., Barta, G. and van Tulder, R. (2007). Localisation motives for research and development investment of multinational

enterprises: European trends and situation in the New Member States. LocoMotive, Technology Centre ASCR.
Cantwell, J., Dunning, J.H. and Janne, O. (2004). Towards a technology-seeking explanation of U.S. direct investment in the United Kingdom. Journal of International Management 10(1), 5-20
Cantwell, J. and Mudambi, R. (2000). The Location of MNE R&D Activity: The Role of Investment Incentives. Management International Review 40(1), 127-148
Cantwell, J. and Piscitello, L. (2000). Accumulating technological competence: its changing impact on corporate diversification and internationalization. Industrial and Corporate Change 9(1), 21-51
Carlsson, B. (2006). Internationalization of innovation systems: A survey of the literature. Research Policy 35(1), 56-67
Chobanova, Y. (2009). Strategies of Multinationals in Central and Eastern Europe, Basingstoke: Palgrave Macmillan.
Cohen, W. and Levinthal, D. (1989). Innovation and learning: The two faces of R&D. Economic Journal 99(3), 569-596
Cunningham, P. (2009). Demand-side innovation policies. PRO INNO EUROPE Policy Brief 1/2009
Damijan, J., Knell, M., Majcen B., and Rojec, M. (2003). The role of FDI, R&D accumulation and trade in transferring technology to transition countries: evidence from firm panel data for eight transition countries. Economic Systems 27(2), 189-204.
Dasgupta, P. and Stiglitz, J. (1980). Industrial Structure and the Nature of Innovative Activity, Economic Journal 90, 226-293.
Djankov, S. and Murrel, P. (2002). Enterprise restructuring in transition: a quantitative survey. Journal of Economic Literature 40(3), 739-792.
Dunning, J.H. (2008). Institutional reform, FDI and the location competitiveness of European transition economies. In: Dunning, J.H. and Gugler, P. (eds), Foreign direct investment, location and competitiveness, Oxford: Elsevier, pp. 175-201.
Dunning, J.H. (2002). Global capitalism, FDI and competitiveness: The selected essays of John H. Dunning. Edward Elgar, Cheltenham.
Figueiredo, P. (2011). 'The role of dual embeddedness in the innovative performance of MNE subsidiaries: evidence from Brazil'. Journal of Management Studies, forthcoming
Filippov, S. and Kalotay, K. (2009). New Europe's Promise for Life Sciences? In: Dolfsma, W., Duysters, G. and Costa, I. (eds), Multinationals and Emerging Economies: The Quest for Innovation and Sustainability. Edward Elgar, Cheltenham.
Garmel, K, Maliar, L. and Maliar, S. (2008). EU eastern enlargement and foreign investment: Implications from a neoclassical growth model. Journal of Comparative Economics 36(2), 307–325.
Girma, S., D. Greenaway y K. Wakelin (2001). Who benefits from foreign direct investment in the UK?, Scottish Journal of Political Economy 48(2), pp. 119-133
Görg, H. and Strobl, E. (2001). Multinational companies and productivity spillovers: a meta-analysis. The Economic Journal 111 (475), 723–739
Guellec, D. and van Pottelsberghe de la Potterie, B. (2001). The internationalisation of technology analyzed with patent data. Research Policy 30(8), 1253-1266.
Guimón, J. (2009). Government strategies to attract R&D-intensive FDI. Journal of Technology Transfer 34(4), 364-379
Günther, J., Jindra, B. and Stephan, J. (2009). FDI and the National Innovation System – Evidence from Emerging Economies in Central and Eastern Europe. Globelics 2009 Conference, October 6-8, Dakar.

Hall, B. and Van Reenen, J. (2000). How effective are fiscal incentives for R&D? A review of the evidence. Research Policy 29 (4-5), 449-469

Hancké, B. and Kurekova, L. (2008). Varieties of capitalism and economic governance in Central Europe. Report for NewGov/STACEE. September 2008.

Harris, W. (2005). Secrets of the Celtic Tiger: Act two. Issues in Science and Technology, Summer 2005.

Harris, R, Li, Q. and Trainor, M. (2008). Is a higher rate of R&D tax credit a panacea for low levels of R&D in disadvantaged regions? Research Policy 38(1), 192-205

Hedge, D. and Hicks, D. (2008). The maturation of global corporate R&D: Evidence from the activity of U.S. foreign subsidiaries. Research Policy 37(3), 390-406.

Inzelt, A. (1999). The transformation role of FDI in R&D: Analysis based on material from a databank. In: Dyker, D.A. and Radosevic, S. (eds.), Innovation and structural change in post-socialist countries: A quantitative approach. Kluwer Academic Publishers, The Netherlands, pp. 185-201

Javorcik, B. and Spatareanu, M. (2008). To share or not to share: Does local participation matter for spillovers from foreign direct investment? Journal of Development Economics 85(1-2), 194-217

Krugman, P. (1997). Good news for Ireland: A geographical perspective. In: Gray, A. (ed.), International Perspectives on the Irish Economy, Indecon, Dublin

Lall, S. (2004). Reinventing industrial strategy: the role of government policy in building industrial competitiveness. G-24 Discussion Paper Series No. 28, April 2004, United Nations Conference on Trade and Development, New York and Geneva.

Lavigne, M. (2000). Ten years of transition: a review article. Communist and Post-Communist Studies 33(4), 475-483

Liang, G. (2004) New Competition: Foreign Direct Investment and Industrial Development in China, ERIM, Rotterdam

Liu, W. and Dicken, P. (2006). Transnational corporations and ‘obligated embeddedness’: foreign direct investment in China’s automotive industry. Environment and Planning A, 38(7), 1229-1247

Majcen, B., Radošević, S. and Rojec, M. (2009). Nature and determinants of productivity growth of foreign subsidiaries in Central and East European countries. Economic Systems 33, 168-184

Mansfield, E., Teece, D. and Romeo, A. (1979). Overseas research and development by US-based firms. Economica 46, 187-196.

McKean, R.N. (1965). The Unseen Hand in Government. The American Economic Review 55(3), pp. 496-506

Meyer, K.E. and Jensen, C. (2003). Foreign investor strategies in view of EU enlargement. In: Stuting, H., Dorow, W., Blaszejewski, S. and Claasenm F. (eds.) “Change Management in Transformation Economies: Integrating Strategy, Structure and Culture, Palgrave Macmillan, London

Meyer-Krahmer, F. and Reger, G. (1999). New perspectives on the innovation strategies of multinational enterprises: lessons for technology policy in Europe, Research Policy 28 (7), 751-776

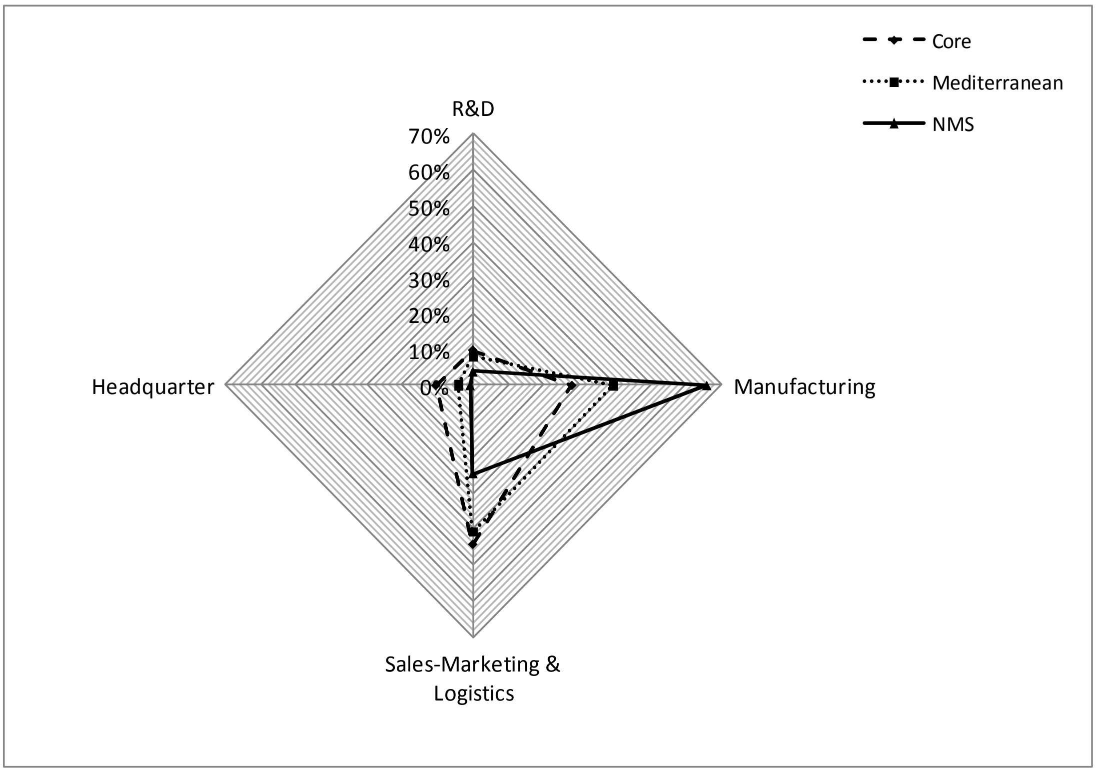
Mortimore, M. and Vergara, S. (2006). Targeting winners: can FDI policy help Developing countries industrialize? In: Lall, S. and Narula, R. (Eds.), Understanding FDI-Assisted Economic Development. Routledge, London.

Mytelka, L. and Barclay, L. (2006). Using foreign investment strategically for innovation. In Lall, S. and Narula, R. (Eds.), Understanding FDI-assisted economic development, Routledge, London.
Narula, R. and Bellak, C. (2009). EU enlargement and consequences for FDI assisted industrial development. Transnational Corporations 18(2), 69-90.
Narula, R. and Dunning, J.H. (2010). Multinational enterprises, development and globalisation: Some clarifications and a research agenda. Oxford Development Studies 38(3), pp. 263-287
Narula, R. and Zanfei, A. (2004), Globalization of innovation: The role of multinational enterprises. In: Fagerberg, J., Mowery, D. and Nelson, R. (eds.), Handbook of Innovation. Oxford University Press, Oxford.
OECD (2006). Government R&D funding and company behaviour: Measuring behavioural additionality. Organization for Economic Cooperation and Development, Paris.
OECD (2009). Science, Technology and Industry Scoreboard 2009. Organization for Economic Cooperation and Development, Paris.
Ostry, S. and R. Nelson (1995). Techno-Nationalism and Techno-Globalism. The Brookings Institution, New York.
Pearce, R. (2004). National systems of innovation and the international technology strategy of multinationals, University of Reading Discussion Paper, 006-04, Reading.
Puga, D. and Trefler, D. (2010). Wake up and smell the ginseng: International trade and the rise of incremental innovation in low-wage countries. Journal of Development Economics 91, 64-76
Radosevic, S. (1999). Transformation of science and technology systems into systems of innovation in Central and Eastern Europe: the emerging patterns and determinants. Structural Change and Economic Dynamics 10(3-4), 277-320.
Radosevic, S. (2003). Patterns of preservation, restructuring and survival: science and technology policy in Russia in the post-Soviet era. Research Policy 32(6), 1105-1124.
Radosevic, S. (2004). A two-tier or multi-tier Europe? Assessing the innovation capabilities of Central and Eastern European countries in the enlarged EU. Journal of Common Market Studies 42(3), 641-666
Radosevic, S. (2006). Central and Eastern Europe between domestic and foreign led modernization, Working Paper.
Ruane, F. and Buckley, P. (2006). Foreign direct investment in Ireland: Policy implications for emerging economies. The World Economy 29 (11), 1611-1628
Rugman, A. and Verbeke, A. (2008). Location, Competitiveness and the Multinational Enterprise. In: Rugman, A. and Thomas, L. (eds.) The Oxford Handbook of International Business. Oxford University Press, pp. 151-169
Santangelo, G. (ed.) (2005). Technological Change and Economic Catch-up. The Role of Science and Multinationals. Edward Elgar, Cheltenham.
Sinani, E. & Meyer, K.E. (2004). Spillovers from technology transfer: The case of Estonia. Journal of Comparative Economics 32(3), 445-466.
Thursby, J. and Thursby, M. (2006). Where is the new science in corporate R&D? Science, Vol. 314, 8 December 2006.
UNCTAD (2005). World Investment Report 2005: Transnational Corporations and the internationalization of R&D. United Nations Conference on Trade and Development, New York and Geneva.

Figure 1 Impact of MNE subsidiaries on national innovation systems

Opportunities:	**Risks:**
Direct benefits: - More R&D expenditure - More employment in R&D - More patents *Indirect benefits:* - Domestic and foreign linkages - Learning-through-interacting - Competition effect - Employment effect - Demonstration effect - Imitation effect	- Crowding-out of local firms - Increased foreign dependency and loss of control - Corporate restructurings (e.g. post-acquisition)
Factors to consider in impact evaluation: - Mode of entry (M&As versus Greenfield investments) - Motivations and nature of R&D activity (demand-driven versus supply-driven, etc.) - Absorptive capacity of innovation system (universities, clusters, linkages, etc.) - Industry trends and corporate strategies	

Figure 2 Functional structure of Greenfield FDI (% share of each function in total FDI announcements from 1997 to 2006)



Source: Table 4.

Table 1 R&D expenditure of MNE subsidiaries as a percentage of total business expenditure in R&D

	1994[1]	**2000[2]**	**2006[3]**
Czech Republic	20.9	36.9	58.6
Hungary	22.6	68.4	57.8
Poland	10.3	13.1	21.7
Slovakia	4.1	15.2	64.1
Average NMS [4]	**14.5**	**33.4**	**50.6**
Average Mediterranean [5]	**30.0**	**32.5**	**36.5**
Average core [6]	**25.2**	**31.3**	**39.6**

Notes: **1.** 1995 for Czech Republic, Finland, Germany, Ireland, Spain and Sweden. 1997 for Poland and Netherlands. Manufacturing sector only for Germany, Ireland, Portugal, Slovakia and Spain, across all years. **2.** 2001 for France, Germany, Italy, Portugal, Spain and Sweden. **3.** 2005 for Belgium, Germany, Hungary, Ireland, Portugal, Slovakia, Spain and Sweden. 2004 for Netherlands. **4.** Mean for the 4 NMS in the sample. **5.** Mean for 3 Mediterranean countries (Italy, Spain and Portugal) **6.** Mean for 8 core countries (Belgium, Finland, France, Germany, Ireland, Netherlands, Sweden and United Kingdom).

Sources: OECD (2009) and UNCTAD (2005).

Table 2 Foreign ownership of domestic inventions

	1981-1985[1]			1991-1995			2001-2005		
	Total[2]	Foreign[3]	Share[4]	Total	Foreign	Share	Total	Foreign	Share
Bulgaria	82	2	2.4%	25	10	40%	43	37	86.0%
Czech Rep.	0	0	-	1	0	0%	205	161	78.5%
Estonia	0	0	-	1	1	100%	21	18	85.7%
Hungary	434	32	7.4%	304	64	21.1%	287	206	71.8%
Latvia	0	0	-	0	0	-	11	9	81.8%
Lithuania	0	0	-	0	0	-	18	17	94.4%
Poland	110	26	23.6%	55	44	80%	175	153	87.4%
Romania	22	1	4.5%	8	5	62.5%	41	41	100%
Slovakia	0	0	-	0	0	-	52	41	78.8%
Slovenia	0	0	-	14	6	42.9%	90	49	54.4%
NMS [5]	**648**	**61**	**9.4%**	**408**	**130**	**31.9%**	**943**	**732**	**77.6%**
Mediterranean [5]	**3 749**	**1 280**	**34.1%**	**6 740**	**2 098**	**31.1%**	**10 607**	**4 249**	**40.1%**
Core [5]	**47 537**	**11 911**	**25.1%**	**61 987**	**18 043**	**29.1%**	**118764**	**39 377**	**33.0%**

Notes: **1.** Provides 5 year interval for each measurement instead of individual years in an attempt to collect sufficient data for most countries. **2.** Number of patents filed in USPTO with at least one domestic inventor. **3.** Number of patents from 2 that are owned by a foreign entity. **4.** Share of 3 in 2. **5.** Sum for all the countries comprising each group (10 NMS, 4 Mediterranean and 11 core countries).

Source: Authors' calculations based on patent counts in USPTO.

Table 3. Annual growth rate of USPTO patents by nationality of owner (%)

	Total		Foreign owner		National owner	
	1983-1993	1993-2003	1983-1993	1993-2003	1983-1993	1993-2003
NMS	-4.5	8.7	7.9	18.9	-7.2	-2.7
Mediterranean	6.0	4.6	5.1	7.3	6.5	3.2
Core	2.7	6.7	4.2	8.1	2.1	6.1

Note: The median year from each time interval in Table 2 is taken as the basis for calculating average annual growth rates for a ten year period.

Source: Table 2.

Table 4 Functional structure of FDI announcements (% share of each function in total FDI announcements from 1997 to 2006)

	R&D	Head-quarters	Manu-facturing	Sales & Marketing	Logistics	Other[1]	Sample size
Bulgaria	3.1	0.3	60.8	29.9	5.2	0.7	291
Czech Republic	6.4	0.9	69.8	12.4	4.9	5.5	849
Estonia	0.6	0	58.4	21.3	11.2	8.5	178
Hungary	4.2	1.4	67.1	12.5	8.4	6.4	1 026
Latvia	1.6	0	42.3	37.4	13	5.7	123
Lithuania	1.3	0.7	48.3	40.4	7.9	1.4	151
Poland	3.1	0.7	67.2	15.2	8.7	5.1	1 046
Romania	4.0	1.2	64.9	20.6	5.2	4.0	499
Slovakia	2.1	0.3	73.8	13.9	6.6	3.3	332
Slovenia	6.3	0	56.3	29.2	8.2	0	48
***Average NMS*[2]**	**3.3**	**0.6**	**60.9**	**23.3**	**7.9**	**4.0**	**4 543**
Avg.Mediterranean	**8.1**	**7.4**	**39.4**	**33.4**	**4.1**	**7.6**	**2 093**
Average Core	**9.9**	**8.8**	**27.9**	**35.6**	**10.4**	**7.5**	**15 867**

Notes: **1.** Other functions include: contact centres, shared services centres, testing & servicing, and others. **2.** Average values for the country groups correspond to unweighted mean.

Source: Authors' calculations based on European Investment Monitor database from Ernst and Young

Table 5 Selected indicators

	R&D expenditure[1]	R&D personnel[2]	USPTO patents[3]	Knowledge Economy Index[4]	GDP per capita[5]
Bulgaria	0.5	0.5	5.5	43	41
Czech Republic	1.5	1.0	20.1	28	80
Estonia	1.3	0.7	15.5	21	67
Hungary	1.0	0.7	28.3	27	64
Latvia	0.6	0.5	4.7	32	57
Lithuania	0.8	0.8	5.2	31	62
Poland	0.6	0.4	4.6	37	56
Romania	0.6	0.3	1.9	47	42
Slovakia	0.5	0.6	9.7	36	72
Slovenia	1.7	1.1	45.1	25	91
Average NMS	**0.9**	**0.7**	**9.2**	**33**	**63**
Average Mediterranean	**1.2**	**0.9**	**88.1**	**31**	**94**
Average core	**2.4**	**1.4**	**452.6**	**10**	**135**

Notes and sources: **1.** Total intramural R&D expenditure as percentage of GDP in 2008 (2007 for Greece). Source: Eurostat Science and Technology Statistics.
2. Research and development personnel as percentage of the labour force in 2008 (2007 for Greece and France). Source: Eurostat Science and Technology Statistics. **3.** Number of patents registered in USPTO from 2001 to 2005 per million inhabitants. Sources: Authors' calculations through patent counts in USPTO and Eurostat Population Statistics for population in 1983, 1993 and 2003. **4.** Knowledge Economy Index 2009. Position in ranking. This index ranks virtually all countries in the world according to different indicators of their economic incentive regime, innovation, education and ICT. Source: World Bank. **5.** GDP per capita in Purchasing Power Standards (PPS) as a percentage of EU average in 2008 (2007 for Romania). Source: Eurostat, National Accounts.

The UNU-MERIT WORKING Paper Series

2010-01 *Endogenous Economic Growth through Connectivity* by Adriaan van Zon and Evans Mupela
2010-02 *Human resource management and learning for innovation: pharmaceuticals in Mexico* by Fernando Santiago
2010-03 *Understanding multilevel interactions in economic development* by Micheline Goedhuys and Martin Srholec
2010-04 *The Impact of the Credit Crisis on Poor Developing Countries and the Role of China in Pulling and Crowding Us Out* by Thomas H.W. Ziesemer
2010-05 *Is there complementarity or substitutability between internal and external R&D strategies?* by John Hagedoorn and Ning Wang
2010-06 *Measuring the Returns to R&D* by Bronwyn H. Hall, Jacques Mairesse and Pierre Mohnen
2010-07 *Importance of Technological Innovation for SME Growth: Evidence from India* by M. H. Bala Subrahmanya, M. Mathirajan and K. N. Krishnaswamy
2010-08 *Economic Adversity and Entrepreneurship-led Growth: Lessons from the Indian Software Sector* by Suma Athreye
2010-09 *Net-immigration of developing countries: The role of economic determinants, disasters, conflicts, and political instability* by Thomas H.W. Ziesemer
2010-10 *Business and financial method patents, innovation, and policy* by Bronwyn H. Hall
2010-11 *Financial patenting in Europe* by Bronwyn H. Hall, Grid Thoma and Salvatore Torrisi
2010-12 *The financing of R&D and innovation* by Bronwyn H. Hall and Josh Lerner
2010-13 *Occupation choice: Family, Social and Market influences* by Ezequiel Tacsir
2010-14 *Choosing a career in Science and Technology* by Ezequiel Tacsir
2010-15 *How novel is social capital: Three cases from the British history that reflect social capital* by Semih Akcomak and Paul Stoneman
2010-16 *Global Players from Brazil: drivers and challenges in the internationalization process of Brazilian firms* by Flavia Carvalho, Ionara Costa and Geert Duysters
2010-17 *Drivers of Brazilian foreign investments – technology seeking and technology exploiting as determinants of emerging FDI* by Flavia Carvalho, Geert Duysters and Ionara Costa
2010-18 *On the Delivery of Pro-Poor Innovations: Managerial Lessons from Sanitation Activists in India* by Shyama V. Ramani, Shuan SadreGhazi and Geert Duysters
2010-19 *Catching up in pharmaceuticals: a comparative study of India and Brazil* by Samira Guennif and Shyama V. Ramani
2010-20 *Below the Radar: What does Innovation in Emerging Economies have to offer other Low Income Economies?* by Raphael Kaplinsky, Joanna Chataway, Norman Clark, Rebecca Hanlin, Dinar Kale, Lois Muraguri, Theo Papaioannou, Peter Robbins and Watu Wamae
2010-21 *Much ado about nothing, or sirens of a brave new world? MNE activity from developing countries and its significance for development* by Rajneesh Narula
2010-22 *From trends in commodities and manufactures to country terms of trade* by Thomas H.W. Ziesemer
2010-23 *Using innovation surveys for econometric analysis* by Jacques Mairesse and Pierre Mohnen

2010-24 *Towards a New Measurement of Energy Poverty: A Cross-Community Analysis of Rural Pakistan* by Bilal Mirza and Adam Szirmai

2010-25 *Discovery of the flower industry in Ethiopia: experimentation and coordination* by Mulu Gebreeyesus and Michiko Iizuka

2010-26 *CSR and market changing product innovations: Indian case studies* by Shyama V. Ramani and Vivekananda Mukherjee

2010-27 *How firms innovate: R&D, non-R&D, and technology adoption* by Can Huang, Anthony Arundel and Hugo Hollanders

2010-28 *Sure Bet or Scientometric Mirage? An Assessment of Chinese Progress in Nanotechnology* by Can Huang and Yilin Wu

2010-29 *Convergence of European regions: a reappraisal* by Théophile T. Azomahou, Jalal El ouardighi, Phu Nguyen-Van and Thi Kim Cuong Pham

2010-30 *Entrepreneurship and the National System of Innovation: What is Missing in Turkey?* by Elif Bascavusoglu-Moreau

2010-31 *Keeping the eclectic paradigm simple: a brief commentary and implications for ownership advantages* by Rajneesh Narula

2010-32 *Brazilian Aerospace Manufacturing in Comparative Perspective: A Brazil/USA Comparison of Output and Productivity* by Daniel Vertesy and Adam Szirmai

2010-33 *Economic restructuring and total factor productivity growth: Tunisia over the period 1983-2001* by Sofiane Ghali and Pierre Mohnen

2010-34 *Impact of government support on R&D and innovation* by Abraham Garcia and Pierre Mohnen

2010-35 *Product, process and organizational innovation: drivers, complementarity and productivity effects* by Michael Polder, George van Leeuwen, Pierre Mohnen and Wladimir Raymond

2010-36 *Entrepreneurship Development and the Role of Economic Transition in Entrepreneurial Activities in China* by Ying Zhang and Geert Duysters

2010-37 *Pro-Poor, Entrepreneur-Based Innovation and it's Role in Rural Development* by Lina Sonne

2010-38 *Financing pro-poor entrepreneur-based innovation: A review of existing literature* by Lina Sonne

2010-39 *India's Rural Financial System: Does it Support Pro-Poor Innovation?* by Lina Sonne

2010-40 *How effective are level-based R&D tax credits? Evidence from the Netherlands* by Boris Lokshin and Pierre Mohnen

2010-41 *Analysing Multidimensional Poverty in Guinea: A Fuzzy Set Approach* by Fatoumata Lamarana Diallo

2010-42 *Bottom-up, Bottom-line: Development-Relevant Enterprises in East Africa and their Significance for Agricultural Innovation* by Andy Hall, Norman Clark and Andy Frost

2010-43 *Assessing Innovations in International Research and Development Practice* by Laxmi Prasad Pant

2010-44 *Research Into Use: Investigating the Relationship between Agricultural Research and Innovation* by Andy Hall, Jeroen Dijkman and Rasheed Sulaiman V.

2010-45 *The global institutional frameworks and the diffusion of renewable energy technologies in the BRICS countries* by Isabel Maria Freitas, Eva Dantas & Michiko Iizuka

2010-46 *The role of patent protection in (clean/green) technology transfer* by Bronwyn H. Hall and Christian Helmers

2010-47 *Localisation Strategies of Firms in Wind Energy Technology Development* by Radhika Perrot and Sergey Filippov

2010-48 *The R&D activity of multinational enterprises in peripheral economies: evidence from the EU new member states* by Rajneesh Narula and José Guimón